SINGULARITIES IN WEATHER AT WALLA WALLA, WASH., AS RELATED TO THE INDEX OF ZONAL WESTERLIES

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ABSTRACT

The concept of primary singularities extant in the general circulation, and their relation to secondary singularities in local and regional weather are examined through analysis of the Walla Walla, Wash., daily records of January temperature and June precipitation. The results underline the influence of the hemispheric circulation upon local weather.

INTRODUCTION

The traditionally accepted January thaw in New England and elsewhere on the east coast holds a strong place in the folklore. Slocum [1] in a study of temperature records for Washington, D. C., and Wahl [2], in investigating the New England thaw within the Boston records, presented results that bear on the question of the existence of such a singularity. Both of these studies point up the anomalous warming on the east coast for the period January 20–23. That this tendency is aligned with a change in the synoptic conditions was shown by Wahl with mean maps for the 20th and 27th of January which delineated a change from a westerly circulation pattern to one predominantly northwesterly.

A further stride forward was made by Wahl [3] in a second paper in which the January thaw was related to the mean features of the general circulation by judicious application of the total zonal index of the westerlies to the Boston records. The existence of primary singularities, representing distinct changes in the hemispheric flow pattern and affecting the local or secondary singularities, was reflected in the monthly mean index. It was found that separation of the Boston record into high and low index years led to mean temperature curves with pronounced accentuation of the thaw in the specific low-index singularity curve.

In view of these interesting results it was decided to examine the daily maximum temperature during January and precipitation occurrences during June at Walla Walla, Wash., for evidence of such a primary-secondary singularity relationship in this region. The local climatological conditions suggested that the maximum temperature is more representative of the air-mass regime here than is the mean.

JANUARY TEMPERATURE SINGULARITIES

At first, the entire period of record from 1886–1950, during which radii of site changes were small, was expressed as 3-day running means of daily maximum temperature for January. However, in this paper attention is limited to the 3-day means for the interim period of 1899–1939, the main features of which are similar to the long-term record. This limitation was imposed because the hemispheric zonal indices were available for only the shorter period. The median value of the mean zonal index served as the separation point for the arbitrary division of the period into high and low index years. All those years below the median were taken as low index years, with the remainder ascribed as high index. For each class

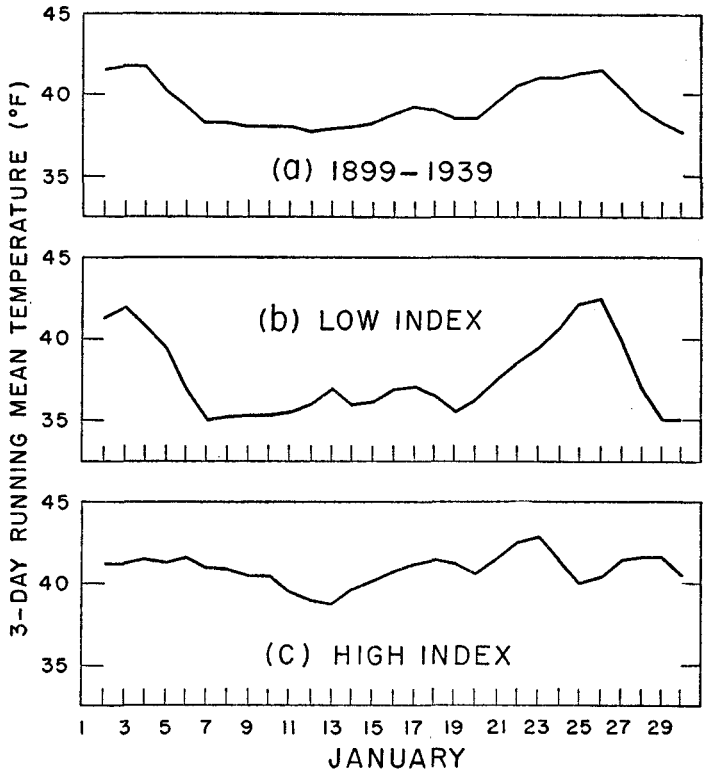

FIGURE 1.—Three-day running mean daily maximum temperatures, Walla Walla, Wash., for January: (a) from 41 years record (1899–1939), (b) from low-index months (20 yr.), (c) from high-index months (21 yr.)

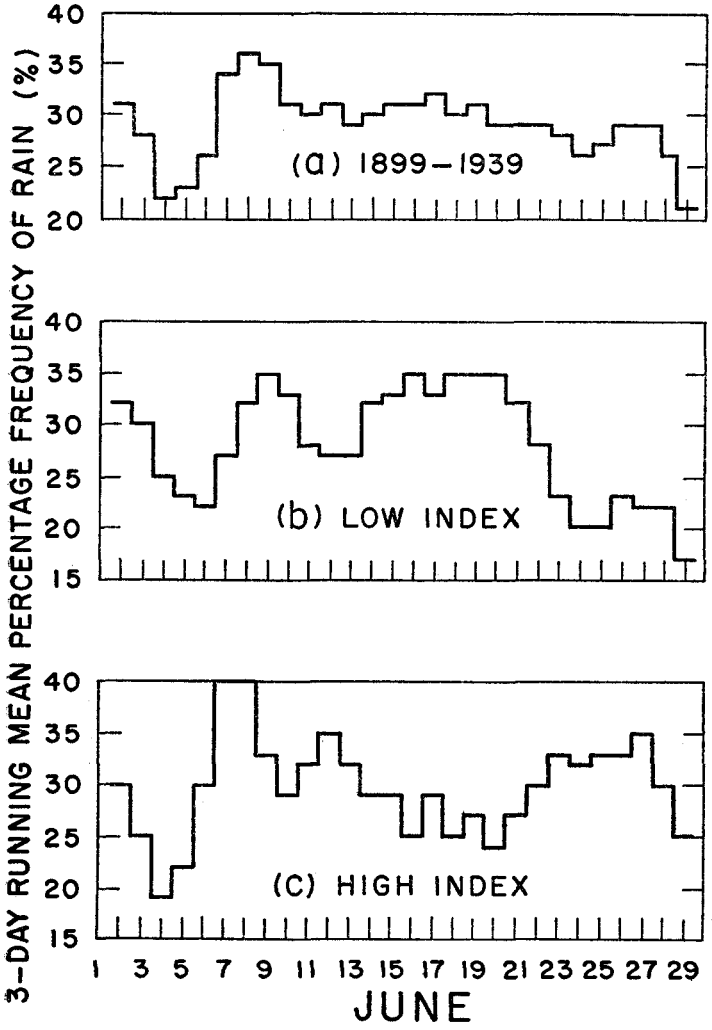

FIGURE 2.—Three-day running mean daily rainfall frequency (%), Walla Walla, Wash., for June: (a) from 41 years record (1899–1939), (b) from low-index months (20 yr.), (c) from high-index months (21 yr.).

3-day running means were derived. Figure 1 shows the results of these derivations.

It is noted in figure 1 that a definite filtering effect is obtained within the index curves. The long-term curve displays a cooling as the month opens which, with but minor rises and falls, continues until January 20. Marked warming then occurs, especially January 23–26, after which steady cooling is manifest at month-end. Both warmer periods are given pronounced delineation by the low index curve at opposite ends of the month. In contrast, cooling is shown for January 23–26 in the high index graph. The smoothness of the high index curve and other features that contrast with the low index curve are in general accord with expectations from synoptic reasoning. For example, the mean map for the entire northern hemisphere for January 26 [4] shows low index conditions in the Pacific as well as in the Atlantic with a double-celled Aleutian Low and pronounced southwesterly flow from the warmer ocean surfaces.

The singularity curves at Walla Walla are substantiated by a curve of maximum temperature at Portland, Oreg., which exhibits a similar pattern (Wahl, unpublished).

JUNE PRECIPITATION SINGULARITIES

An investigation was then made of the Walla Walla records for the frequency of precipitation occurrence in June, the last month of appreciable rainfall for the ripening winter wheat of this region. Again 3-day running means were obtained. The series was smoothed by giving half-weight to days with trace amounts. The smoothed means expressed as percentage frequency of occurrence are shown in figure 2.

These curves for June occurrence of rain at Walla Walla show a type behavior somewhat paralleling the so-called monsoon burst of Europe. It is at once apparent that the first maximum is a high index singularity, the second a low index feature, thus giving rise to apparent alternate dates, either late or early rain according to the index pattern in a specific year.

In addition to the two investigations described above, attempts using more regional indices to characterize the circulation west of the test area were made. However, consistent with Wahl's results for Boston, only less marked separation of the different singularity types was observed.

CONCLUSIONS

The results of this study underline the influence of the hemispheric circulation upon the local behavior of the weather elements, and thus may serve as additional evidence for the value of such local investigations in questions concerning the mechanism of the general circulation.

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